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the urgent request of the committee, and by permission of the Austrian government, he remains a few months to attend to the printing of important papers, which will appear in the next volume of the *Travaux et mémoires* of the bureau, and to superintend the adjustment of the new universal comparator.

In the latter part of 1881 the kingdom of Roumania expressed a desire to subscribe to the regulations of the international commission, and is now numbered among the states represented in that body. The metric system is now used in all official transactions in Roumania; and on the 1st of January, 1884, its use will become compulsory throughout the kingdom.

RECENT EXPLORATIONS IN THE REGION OF THE GULF STREAM OFF THE EASTERN COAST OF THE UNITED STATES BY THE U. S. FISH-COMMISSION.¹

1. Introductory.

ALTHOUGH several extended surveys along the region of the Gulf Stream had been made by the officers of the U. S. coast-survey since 1844, no systematic dredging had been done along its course, north of Florida, until 1880. During the previous surveys, large numbers of bottom samples had been saved. Some of these were studied many years ago by Professor Bailey, and later by Mr. L. F. de Pourtales. Many of the Foraminifera and other microscopic forms have been described by them. A few small shells from the same source were described by Dr. A. A. Gould in 1862. These investigations gave a general idea of the nature of the materials of the bottom and the depth, but many errors existed in the earlier surveys in the determinations of temperature, and in many cases the recorded depths were unreliable. The extensive surveys made by the Blake, since 1880, have been conducted with much better apparatus and greater accuracy.

The real character of the fauna inhabiting the bottom beneath the Gulf Stream, off our coast, was completely unknown until 1880, when numerous and successful dredgings were made, first, by Mr. Alexander Agassiz, on the coast-survey steamer Blake (J. R. Bartlett, U.S.N., commanding), and, later in the season, by the U. S. fish-commission party, on the Fish Hawk. The Challenger, on her celebrated

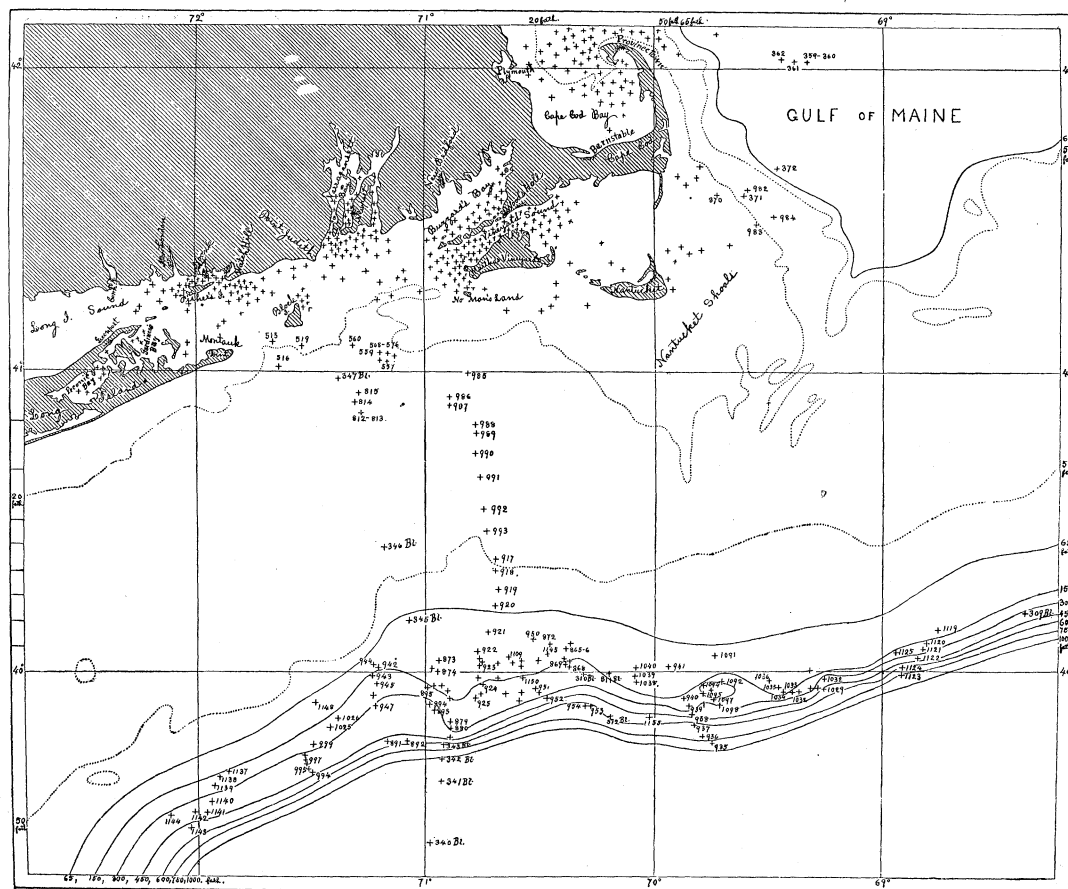
voyage, made a line of dredgings from Bermuda toward New York; but, on approaching our coast, she turned northward, and went to Halifax. Her station nearest to our coast was about 160 miles off New York, in 1,240 fathoms. This is much farther off the coast than any of the fish-commission dredgings, and outside the Gulf Stream slope. The few dredgings made by the Challenger off Halifax were partly on the shallow fishing-banks (Le Have bank), and partly in the deep water of the Atlantic basin. By mere chance, therefore, the Challenger missed the discovery of the exceedingly rich and varied deep-water fauna that is now known to occupy the Gulf Stream slope all along our coast. In 1872 one haul was made by Messrs. S. I. Smith and O. Harger, on the Bache, in 430 fathoms, south of George's bank, on this slope; but it happened to be on a comparatively barren spot. In 1877 the U. S. fish-commission party dredged on the northward continuation of the slope, about 120 miles south of Halifax, in 90 and 190 fathoms; but the bottom was of barren gravel, and the results meagre and unsatisfactory. In that region the cold currents are rapid, and the slope of the bottom is exceedingly steep, making the dredging very difficult. In 1880 Mr. A. Agassiz, while on the Blake, made several lines of dredgings off our eastern coast, crossing the Gulf Stream slope. The most southern of these were off the Carolina coasts, and the most northern stations were just south of George's bank. These dredgings extended from shallow water to 1,632 fathoms. The Blake was furnished with excellent apparatus for sounding and dredging, temperature determinations, etc. The officers of the Blake secured by this exploration a large amount of reliable physical data; and Mr. Agassiz obtained very interesting collections, including large numbers of new forms of animal life, many of which have already been described in the bulletin of the Museum of comparative zoölogy.

Later in the season of 1880, the U. S. fish-commission dredging-party, under the direction of the writer, made its first expedition to the Gulf Stream slope in the steamer Fish Hawk (Lieut. Z. L. Tanner commanding). The region visited was about 75 to 80 miles south of Martha's Vineyard, in 65 to 192 fathoms. On Sept. 4, when this ground was first visited by us, a long day was spent in dredging and trawling, and with marvellous results. The bottom was found to be occupied by an exceedingly rich and abundant fauna, including great numbers of new and strange forms of

¹ This article is published by permission of the U. S. fish-commission.

animals belonging to nearly all the marine orders. Many fishes never before taken on our coast were secured. Thousands of beautiful and undescribed star-fishes of many species, with varied shapes and colors, encumbered our deck. Crabs and shrimps of strange kinds, some of them of large size, were taken by thousands. Numerous new and curious species

though aided by the officers and sailors of the steamer, who shared more or less in our enthusiasm,—from daylight in the morning till late at night, to preserve what we had secured, notwithstanding we threw away many thousands of duplicates. Some idea of the richness of this fauna, and of the abundance of life on the bottom in this region, may be



MAP I. — Southern coast of New England to the Gulf Stream slope, showing lines of depth and the positions of the principal dredging-stations of the U. S. fish-commission, 1871, 1874, 1875, 1880-82. The crosses (+) indicate dredging-stations, part of which are accompanied by their serial numbers corresponding to the records and published lists. Those bearing numbers between 309 and 347 were occupied by the Blake in 1880.

of shells, some of them very beautiful; bushels of large and brilliantly colored sea-anemones, several of them over a foot across, and most of them previously unknown; with sea-pens and corals of elegant forms and colors,—were among the more conspicuous treasures secured on that ever memorable day. So successful were we, that it required the most diligent and devoted labor on the part of our entire party,—

gathered from the fact that it required about five barrels of alcohol to preserve the portion of the catch that we saved on this one day, and a similar amount was used by us on various subsequent trips in a single day. On our first day eight hauls were made, mostly with a large beam-trawl. There was a very heavy swell, due to a violent cyclone that had prevailed farther south a few days before.

Under these circumstances, the dredging and the care of the specimens were unusually tiresome: otherwise our enthusiasm would, per-

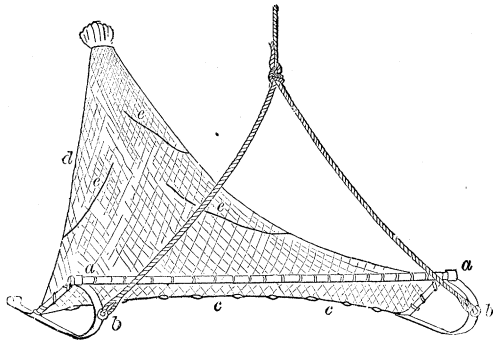


FIG. 1. — The beam-trawl. The length of the beam, *a, a*, varies from 12 to 15 feet in those used by us. The height of the iron runners, *b, b*, supporting the beam, varies from 24 to 30 inches; the length of the net, *d*, from 25 to 35 feet or more. The pockets, *e*, within the net, are to prevent the escape of fishes. The drag-rope, *c, c*, is weighted with lead sinkers.

haps, not have allowed us to retire, even at midnight. But a touch of genuine seasickness will dampen the ardor even of the most enthusiastic naturalists when hundreds of new and strange species are before them.

This first trip having been so successful, two others were made, later in the season, to other parts of the slope, in depths ranging from 85 to 500 fathoms. Each trip proved equally productive, and added many species to the long list of discoveries.

In 1880 the headquarters of the fish-commission were at Newport, R.I.; but in 1881 and 1882 they were at Wood's Holl, Mass., where a laboratory had already been fitted up in 1875. In 1881 and 1882 the exploration of the Gulf Stream slope was continued, whenever the weather was sufficiently favorable to permit us to make a trip in the Fish Hawk without too much risk.

The steamer Fish Hawk, with which we have explored this region during the past three seasons, was built particularly for use in the hatching of shad-eggs in the mouths of shallow rivers, and was therefore not adapted for service at sea, unless in fine weather. A much larger iron steamer — the Albatross, of 1,000 tons — has recently been built for the use of the fish-commission, and is now being fitted up expressly for deep-sea service, for which she will be in every respect well adapted, and will have the best equipment possible for such investigations at all depths. The examination of the bottom beyond the depth of about

700 fathoms has, therefore, been deferred until the completion of the Albatross.

In addition to the three trips made in 1880, seven trips were made by us in 1881 from Wood's Holl, and in 1882 five trips. During these fifteen trips, on each of which a single entire day was usually employed in dredging, we occupied about 113 stations. At nearly all these stations we used a large beam-trawl of improved construction (fig. 1). In a few

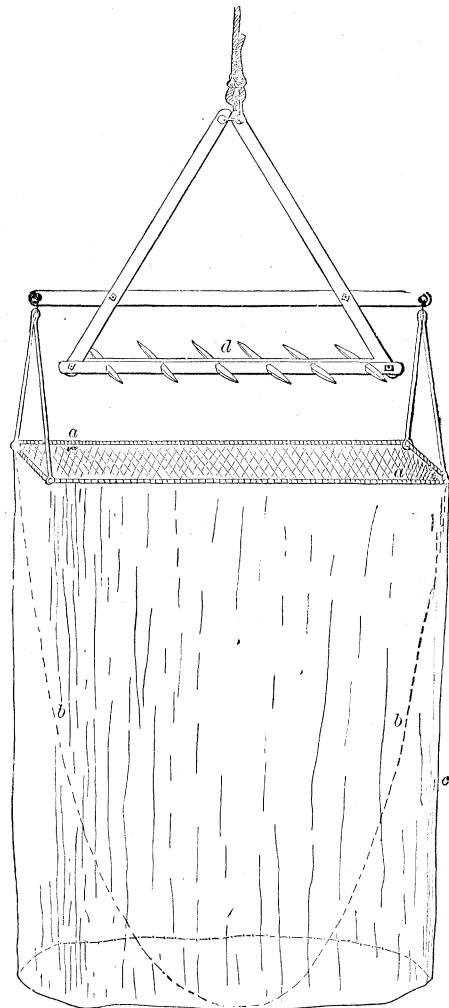


FIG. 2. — The rake-dredge rigged for use. The iron frame carrying the teeth, *d, d*, is about 3 feet wide; the teeth, about a foot long. The frame, *a*, carrying the net, *b*, is 4 feet long; *c* is a canvas bag to protect the net.

instances we used a large rake-dredge (fig. 2). On every trip fine surface-nets, or towing-

nets (fig. 3), were used to capture free-swimming animals, whenever the motion of the steamer was sufficiently slow to permit

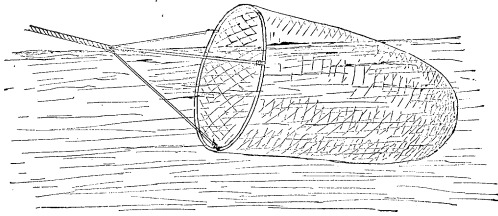


FIG. 3.—The towing-net, in the position that it takes while in use, half buried beneath the surface of the water. Those used by us are mostly 10 to 14 inches in diameter.

this mode of collecting. In these towing-nets, and in long-handled dip-nets, we secured a great variety of pelagic creatures, such as jelly-fishes, *Salpa*, *Sagitta*, various small Crustacea, and especially large numbers of Entomostraca.

Our dredgings in this region now cover a belt about 160 miles long, east and west, and about 10 to 25 miles wide. The most eastern stations are south-east of Cape Cod; the most western are south of Long Island. They are mostly between 80 and 110 miles from the coast-line of southern New England (see map, p. 444). The

regular work of the party during the season, Capt. Tanner made a special trip to the Gulf Stream slope, off Chesapeake Bay, in 1880, and another off Delaware Bay in 1881. On both of these occasions valuable collections were made, and additional data in regard to the depth and temperature were obtained. He occupied seven stations, in 18 to 300 fathoms, in 1880; and eight stations, in 104 to 435 fathoms, in 1881. These dredgings show the direct southward continuation of the in-shore cold belt, and the warm belt outside of it, as well as the cold deep-water belt, with but little change in the fauna of each.

2. Physical features of the region.

The total number of species of animals already obtained by us from deep water in this area is not less than 800. The number already identified or described, and entered on our lists of the fauna, is about 650. This number includes neither the Foraminifera nor the Entomostraca, which are numerous, and but few of the sponges. Of this list, less than one-half were known on our coast before 1880, and a large number were entirely unknown to science. Of fishes there are, perhaps, 70 species. Of the whole number, already determined, about 265 are Mollusca, including 14

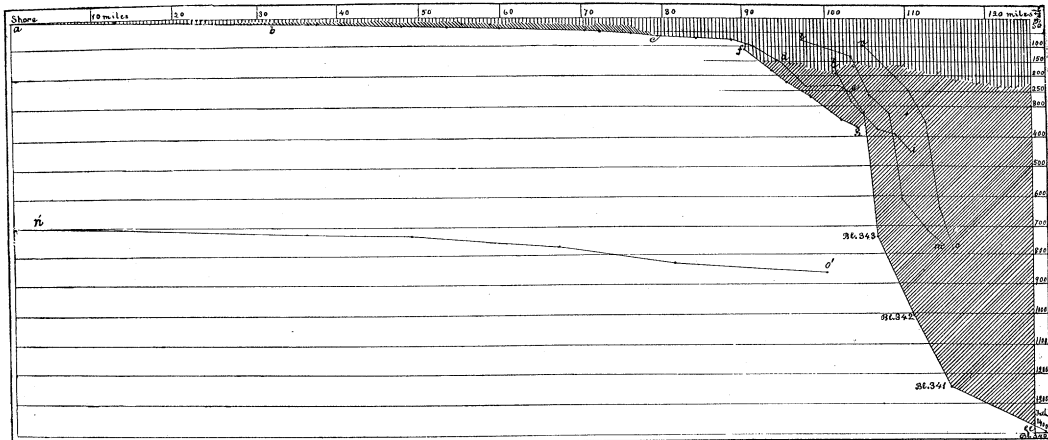


DIAGRAM 1.—To illustrate the relative slope or profile of the bottom, from the shore to the Gulf Stream slope, and across portions of the slope in several lines. Vertical to horizontal scale, 1: 360. The line *n-o* shows the actual slope along the line *n-o*. The vertical shading indicates the position of the comparatively warm water, both of the surface and of the Gulf Stream; oblique shading to the right indicates the cold water of the shallow plateau; oblique to the left, the cold water of the greater depths.

depths are mostly between 65 and 700 fathoms. Probably no other equally large part of the ocean basin, in similar depths, has been more fully examined than this. In addition to the

Cephalopoda; 90 are Crustacea; 60, Echinodermata; 35, Anthozoa; and 65, Annelida.

The apparatus used on the Fish Hawk has been better in many respects than most other

vessels engaged in such work have had. Each year new improvements have been made. The 'trawl-wings,' first introduced by us in 1881, have been used with great success; for they have brought up numerous free-swimming animals from close to the bottom, which would not otherwise have been taken. The use of steel wire for sounding, and of wire rope for dredging, has enabled us to obtain a much greater number of dredgings and temperature observations than would have been possible under the old system of using rope, employed even on the Challenger. The use of steel-wire rope for dredging, first invented by Mr. A. Agassiz, and very successfully employed by him on the Blake, has proved to be an improvement of very great value in deep water. By its use there is an immense saving of time, and consequently a great increase in the value of the results. As an illustration of the rapidity with which dredging has been done on the Fish Hawk by using the wire rope reeled upon a large drum, I give here memoranda of the time required to make a very successful haul. In 640 fathoms, at station No. 1124, the large trawl was put over at 4.29 p.m.; it was on the bottom at 4.44, with 830 fathoms of rope out; commenced heaving in at 5.17; it was on deck at 5.44 p.m.; total time for the haul, 1 hour and 15 minutes. The net contained several barrels of specimens, including a great number and large variety of fishes, as well as of all classes of invertebrata, — probably more than 150 species altogether, many of them new.

At all the localities that we have examined, the temperature of the water, both at the bottom and surface, was taken, as well as that of the air. In many cases, series of temperatures at various depths were also taken. Many other physical observations have also been made and recorded. Lists of the animals from each haul have been made with care, and arranged in tables, so far as the species have been determined up to date.

South of New England the bottom slopes very gradually from the shore to near the 100-fathom line, which is situated from 80 to 100 miles from the mainland. This broad, shallow belt forms, therefore, a nearly level, submarine plateau, with a gentle slope seaward. Beyond the 100-fathom line the bottom descends rapidly to more than 1,200 fathoms into the great ocean-basin, thus forming a rapidly sloping bank, usually as steep as the slope of large mountains, and about as high as Mount Washington, New Hampshire. This is well shown by diagram 1, which illustrates the

relative slope at several lines of dredging, and the *actual* slope $n'-o'$ along the line $n-o$. We call this the Gulf Stream slope, because it underlies the inner portion of the Gulf Stream all along our coast, from Cape Hatteras to Nova Scotia. In our explorations a change of position of less than 10 miles, transverse to the slope, sometimes made a difference of more than 3,500 feet in depth.

[To be Continued.]

THE INTERNATIONAL FISHERIES EXHIBITION.

It is just thirty-two years, nearly the third part of a century, since international exhibitions were inaugurated. The 'Great exhibition' of 1851 marks an epoch in the history of England. It brought with it new aspirations for culture, and new methods of education in science pure and applied, in the arts aesthetic and industrial, arousing them to a new intellectual life. "The Great exhibition of 1851," remarks a popular novelist, a social philosopher as well, "did one great service for country people: it taught them how easy it is to get to London, and what a mine of wealth, especially for after-memory and purposes of conversation, exists in that big place." It gave them the great treasure-houses of South Kensington, and the smaller kindred museums in all parts of the United Kingdom.

The world at large has profited by the same experience, though perhaps to a less degree. Every nation, almost every great city, has had its 'world's fairs,' and, according to its capacity, has profited by their lessons. It is doubtful whether we shall ever see another universal exhibition so extensive as those of Philadelphia (1876), of Vienna (1873), and of Paris (1867). The ideal has become too lofty; and the exhibition of to-day, like the worker, must be devoted to a specialty. The fisheries exhibition, soon to open at South Kensington, is as nearly as possible upon the site of the exhibition of 1851, and covers precisely the same area of ground; namely, twenty-one acres. It would be instructive to estimate how large an extent of territory would be covered by an exhibition in which should be represented, with the minuteness of to-day, all the divisions of the classification of 1851, — a classification, which, for minuteness, comprehensiveness, and philosophical system, has not since been equalled. An entire English shire would hardly suffice.

Special exhibitions have probably entirely superseded those of general scope, and their number is yearly increasing. In one year, re-